Simulation of Alternative Marketing Strategies for U.S. Cotton

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Abstract

Three marketing strategies (selling a put option, cash sale at harvest, and cash sale in June) are simulated based on historical values and ranked based on certainty equivalents for a representative irrigated and dryland cotton farm   Scenario analysis is also used to compare varying yield values.

Key Words: Simulation, Marketing, Cotton, Risk.

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Introduction

Contemporary cotton producers have a number of marketing alternatives available to choose from in selling their product. These marketing decisions can be involve a balancing act between risk management and profit maximization. Some marketing alternatives like forward pricing have been questioned in the light of presumed efficient commodity markets (Zulauf 1998). However, both past and recent evaluations of cotton market efficiency, while indicating long-run efficiency, still highlight seasonal opportunities for hedging higher pre-harvest prices than at harvest time (Curtis 2007). While the most common method of marketing cotton is the Commodity Credit Corporation (CCC) loan program, this program may be made more restrictive by the upcoming farm bill. With the several marketing strategies available for the sale of cotton, the question under study is which alternative will be preferred by a presumably risk averse decision makers.

This study tests several refutable hypotheses that 1) forward pricing (i.e., prior to harvest) in cotton gives significantly higher average net revenue than 2) selling at harvest in the local cash market, or 3) putting the crop into the CCC loan program for deferral of sale the following June. In addition, we evaluate the relative risk efficiency of these marketing alternatives for irrigated and dryland cotton farming. As the problem is essentially an empirical question, the comparison of average net returns and ranking of net returns distributions based on certainty equivalents will be determined by the historical levels, variations, and seasonal patterns of pre-harvest and post-harvest cotton prices. A scenario analysis will be employed to evaluate each strategy, both irrigated and dryland, at a varying cotton farm yield levels of low, average, and high.

Prior study has suggested that hedging strategies in the cotton market may show seasonality and a opportunity for capturing a profit. As Zulauf and Irwin (1998) state, “For cotton, significant returns are found only when hedgers are net short for the entire month prior to the position being taken.” This may suggest that a risk factor could exist for cotton that makes limited seasonal hedging a relevant strategy. Other researchers have studied specific times of year for the best time to forward contract for December cotton contracts. For example, Curtis et al. examined seasonal patterns of December cotton futures and Black-Scholes based estimates of put option prices to identify early March as the optimal time for preharvest hedging with put options. Their results reflected a trade-off between longer time value and relatively low volatility of December options at that point in time

The efficient market hypothesis underlies the argument for cash sale at harvest. The efficiency of the market is demonstrated by a “random walk” of prices over a series of time. An efficient market’s best forecaster of tomorrow’s price is the price today because all publicly available information is obtainable to participants in the market. The theoretical argument for cash sale at harvest is that prices of storable commodities like cotton are difficult to predict. Forward pricing is therefore seen as challenging at best, and perhaps futile. Futures markets have been shown to have varying forecast ability depending on the observed efficiency of the market. Where markets are shown to be more efficient, a forecast model’s ability is reduced and does not show much consistent accuracy at predicting future’s price (Zulauf 1998). In applying a cash sale at harvest strategy, the farmer is content with absorbing the risk associated with taking a price during the harvest season.

The objective of the study was to identify risk efficient marketing strategies for a representative west Texas cotton farm. To accomplish this, the analysis ranked the net revenue distribution of alternative marketing strategies to discover which was dominant based upon certainty equivalents. A Monte-Carlo simulation model was used to make the comparison among 1) forward pricing with put options, 2) selling the crop at harvest using spot price cash sale, 3) cash sale the following June.

Data/Procedures

Evaluating specific preharvest strategies, with specific target prices, begs a larger question of whether hedging is even relevant. That is, does the futures and options market affords frequent enough opportunity for a grower to hedge his/her cost of production? To examine this, we simulated a moving average forecast for the following year's yield was made based off historical price data for daily future and option prices over the last twenty years. The fixed and variable costs associated with the farm are discovered by dividing the predicted yield by the cost data retrieved from the Texas Cooperative Extension Service.

Historical data of cotton futures settlement prices, historical daily put option premiums, historical local prices from county data from one specific county in west Texas, and historical adjusted world price (AWP) were used in the simulation model. Each marketing strategy uses these price data sets as the basis for the forecasted prices used in the model. The county yield data were taken from multiple farms within multiple counties from Crop Insurance records. Individual farms were taken from the counties surrounding and including Hale County. Six individual farms are chosen based on yield values. The data were separated into dryland and irrigated farms to essentially have two models to represent the varied risk associate with the different farming practices. Three irrigated farms and three dryland farms were picked out of the yield data sets based on their ten year historic coefficient of variation, (CV). The CV is the standard deviation of the historic data divided by the mean of the historic data, where it is all multiplied by 100 to derive a percentage. This statistic explains the variance within the historic values and allows a comparison to be drawn between farms. After ranking all of the farm yield data by CV, the median CV farm was selected to represent a middle representative yield. The lower yield farm was selected as the one having standard deviation above the median CV farm and the higher yield farm was picked by one standard deviation below the median CV farm. A CV greater in value (CV>1) indicates higher variance in yield values, while a lower (CV<1) demonstrates a lower variance in yield values, i.e. more consistency in yield production. It happened that the high CV matched with the lower average yields, the low CV matched with the higher average yields, and the median CV matched with a yield between the lower and higher average yield values for dryland and irrigated.

The yield data of the six farms (i.e., high/medium/low yield, by irrigated or dryland) is assigned a unavariate empirical probability distribution. The error term for each yield is given a probability that directly follows the probabilities found throughout the historical data set. This non-normal distribution exactly follows the probabilities found in history, so no value above or below history can be produced based of the mean of history. The empirical distribution essential becomes the error term associated with making the yields stochastic.

Price data were made available through the former New York Board of Trade (now Intercontinental Exchange, or ICE) for futures price for the first trading day in December and June for a December and June contract. Spot price data for the first trading day in December and June for Lubbock, TX as well as adjusted world price historical data for first trading day in December and June were obtained from USDA-AMS data compiled at Texas A&M University (Gleaton 2007). The difference between December's spot price and December's futures price and the difference between June's spot price and June's futures price was used to discover basis for that historical year. All price data for December used prices from 1996 to 2006 while all price data for June used data from 1997 to 2007. The difference in years used is because December was lagged a year because the following June price is more correlated with the previous year's December's price for that marketing year. National price provided by the Agricultural Policy Center from 1996 to 2006 as well as the 2007 FAPRI forecasted price for the August 2007 to July 2008 marketing year. The national price is the average price of cash marketed cotton around the United States.

The price data set was constructed by the collected history and tested for trend as an aid in stabilizing simulation forecasts. Ordinary least squares (OLS) was applied to determine the presence of time trend in historical data (Hughes 1980). No significant trend was found in either the price data or the basis for December and June. The yield data were also found not to have any significant trend.

A multivariate empirical probability distribution was placed on the variables to account for their correlation. Since no trend was found historically in the data, the distribution used percent deviate from mean for the distributions. This type of probability distribution correlates inter-temporal prices by means of a correlation matrix through a non-normal distribution. Correlated uniform standard deviates (CUSD) were formed through the matrix. The error term for each variable was generated when the CUSD's are combined with the empirical probability distribution associated with each variable making these variables stochastic. (Richardson 2000).

The stochastic forecast of national price equaled the FAPRI predicted 2007 price multiplied by one plus the national price distribution (the one accounts for the probability distribution being described as a percentage). Using the national price as a function in determining spot and adjusted world prices, the historic national price data set was regressed against every other price variable, except June and December basis price variables. (Bailey 1985) The regression became the formula for which a deterministic forecast was derived for each other variable. The stochastic forecast for basis used the mean of historical basis multiplied by one plus the basis' probability distribution.

The variables were simulated through software which uses a form of Latin Hyper Cube number generation based on the distribution set around the data point. Latin Hyper Cube evenly distributes the simulated random numbers based of probabilities assigned by the distribution (Richardson 2007). Each strategy was ranked based in terms of certainty equivalents (CE) as the measurement of risk aversion over a defined range. This approach, stochastic efficiency with respect to a function (SERF), reveals the strategy that is most preferred for the representative farm over the historical data. The CE is a measurement of the risk premium associated with a utility curve where a critical point is defined as the decision maker being indifferent between the value and the risky outcome (Hardaker 2004). A breakeven risk aversion coefficient (BRAC) means that a decision maker prefers one strategy over another. As the BRAC changes in number, preference over strategies will change (McCarl 1988). The BRAC used ranking marketing strategies uses the formula 4 divided by net worth. Net worth was determined by using a representative farm from the Texas High Plains assets sheet provided by the Agricultural Policy Center. Assuming that liabilities are 75% of assets, 25% of assets became net worth. At this BRAC, the marketing strategy with the largest CE line determined the preferred strategy.

Results and Discussion

The analysis of available market opportunities found that pre-harvest (January-June) futures price for December contracts covered production costs nearly 90% of the time for a representative dryland and irrigated farm. Figure 1 and Figure 2 show the probabilities of a Futures Price less local basis (six cents) less option premium (three cents) being greater than the variable cost and total cost of production for each management style of farming assuming a strike price of 65 cents at a premium of 3 cents can be made acceptable when looking at historical strike price for the last twenty years. Eleven out of the twenty-one years analyzed (1987-2007 Jan-June) found an ‘out of the money’ put option strike price at 65 cents. Premiums over this time averaged just over one cent per put option. The assumption to make the premium three cents derives for the years where the strike price may be closer to the ‘money.’

The put option strategy involves an assumed set strike price and set premium. Since the model is designed for extension work, these fixed inputs can be changed as the real time market environment changes. Assuming a farmer can find a put option December contract strike price of 65 cents within the first half of the year (January- June) with an associated three cents premium, the option was executed depending on variance of futures price i.e. upward variance will force the model to sell on cash market minus the base (made stochastic by the difference between the stochastic futures and stochastic spot price) and the set premium. The 65 cents strike price was used as a common strike price for this type of hedge.

The forward pricing strategy involves buying a put for a December contract in the first six months of the year of harvest assuming a 65 cents strike price along with a three cents premium is obtainable some time during the six month window. If there is no intrinsic value (intrinsic value for put equals strike minus futures price) then the premium was lost multiplied by the amount hedged. If there was intrinsic value, then the premium for selling the put equals the amount of intrinsic value (time value is assumed to be non-existent because put is sold near expiration of December contract). The amount to be hedged was determined by the expected value of that years harvest based off the history of farm. The actual crop was then sold on the spot market in the month of December.

The cash sale at harvest involved selling the crop on the spot market at time of harvest. The cash sale in June required keeping the crop in storage until June when the loan program for that marketing year expired. Each of these strategies took the spot price for the corresponding month and multiplies that by the yield harvested.

Government support was included in each marketing strategy. The government support was provided in the form of direct payments and counter cyclical for producers. A direct payment works by taking 85 percent of "base acres" (obtained from history) of a farm and multiplies these acres by the "direct payment rate" per unit and the "direct payment yield" obtained from USDA Farm Service Agency. These payments are considered to be de-coupled from price. Counter-cyclical payments work by congress making a target price into law. This target price is the stationary ceiling at which is compared to the seasonal average price for cotton. If the price for cotton falls below this ceiling, a payment is made equaling the target price less the season average price. If the season average price rises above the target price, then no payment is made. (Monke 2004).

The three marketing strategies applied to both an irrigated and dryland representative west Texas cotton farms found consistency in the ranking of strategies as well as a clear dominate strategy from statistical data resourced from the simulation. In every scenario (high, medium, and low yield) found the preferred strategy to be the use of the put option, followed by cash sale at harvest, and then cash sale in June.

The representative irrigated farm saw a positive certainty equivalent value (CE) for the put option strategy in each yield scenario. While the cash sale at harvest and cash sale in June strategies only found a positive CE for the highest yield scenario. The difference between a positive and negative CE is that for a positive CE, the farmer is better farming rather than not farming. A negative CE indicates that the farmer is better off not farming at all if the strategy with the negative CE value is applied. In Figures 3, 4, and 5 shows the SERF analysis that ranks the marketing strategies for each yield scenario based off the strategy's CE value. In each irrigated yield scenario, the put option strategy had the highest CE value followed by cash sale at harvest and then by cash sale in June. Figure 5 shows positive CE's for each strategy which indicated under this yield scenario the farmer would benefit using any of the three strategies rather than not farming. However, the farmer is better off using the put option strategy rather than the cash sale at harvest or the least preferred strategy of cash sale in June.

The representative dryland farm saw a negative CE value for each strategy through each yield scenario. As dryland is an inherently a more risky production strategy, historical values used to generate the stochastic forecast for 2007 saw lower yields and the possibility of years of no production for each yield scenario. Though the put option strategy was the most preferred, followed by cash sale at harvest, and then by cash sale in June, the SERF analysis revealed each strategy as having had produced a negative CE value for each yield scenario. The negative CE value indicated that the farmer is better off not farming at all rather than using any of these strategies analyzed in Figures 6, 7, and 8. The negative CE values are a direct result of the low yields generated from the historical representative yield scenario farms and the higher yield risk associated with dryland farming.

Conclusions

The movement to reduce U.S. government support of the agricultural sector has been gaining momentum. Now the commodity producer may have to look beyond federal farm programs for reducing the risk associated with prices and farm income. While the future of the present CCC loan program is unknown, other marketing strategies are available. This research is comprehensive in that it integrates policy and marketing approaches in price risk management. The research is also timely given the timetable of the farm bill process. This study quantifies the risk/reward trade-off of these strategies while providing a ranking. One limitation of this approach is the assumption that future risk is reflected by historical distributions of price variables.

Even if prices are forecasted to be extremely high during harvest, buying a put option earlier in the year at one's cost of production (if below futures price) provides an out of the money option that translates into cheap insurance if the bottom falls out on price. The producer will only lose the low out of the money premium. Various hedging strategies can be applied to reduce price risk while this analysis only included one, though one demonstrates the potential of the use of derivatives. Years where prices are too low to find a low premium to justify a hedging strategy has occurred historically. The analysis suggests that years were a producer can see an opportunity early in the year to find an affordable premium, the opportunity for the farmer to eliminate price risk presents itself through just such a hedging strategy.

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Figure 1: Dryland Farm: Probability Strike Price is above Production Costs

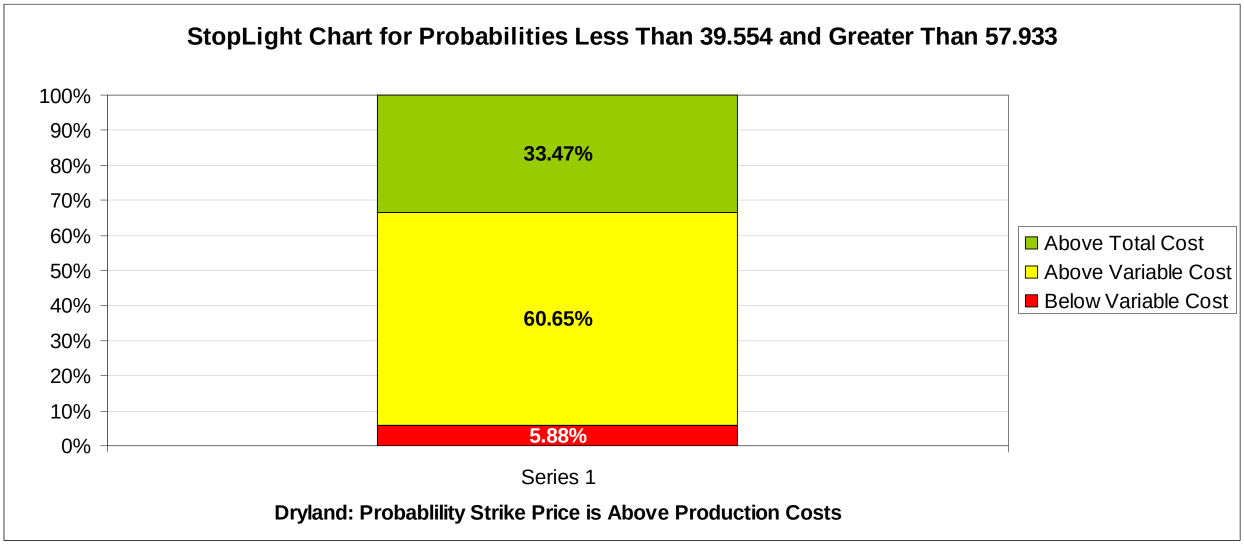

Figure 2: Irrigated Farm: Probability Strike Price is above Production Costs

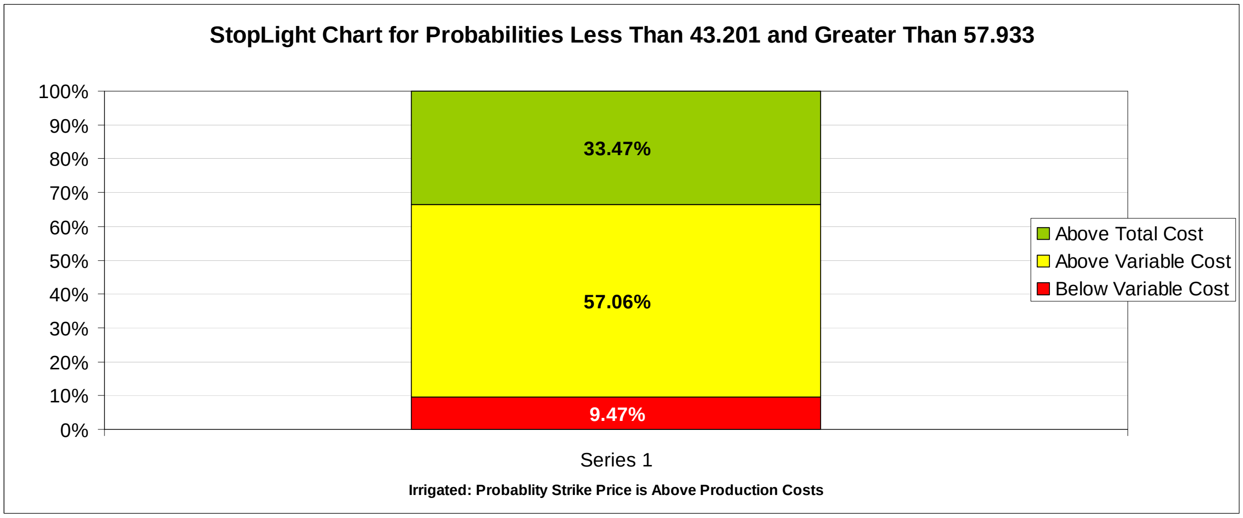

Figure 3: Irrigated Low Yield Farm: SERF Analysis based on Certainty Equivalents

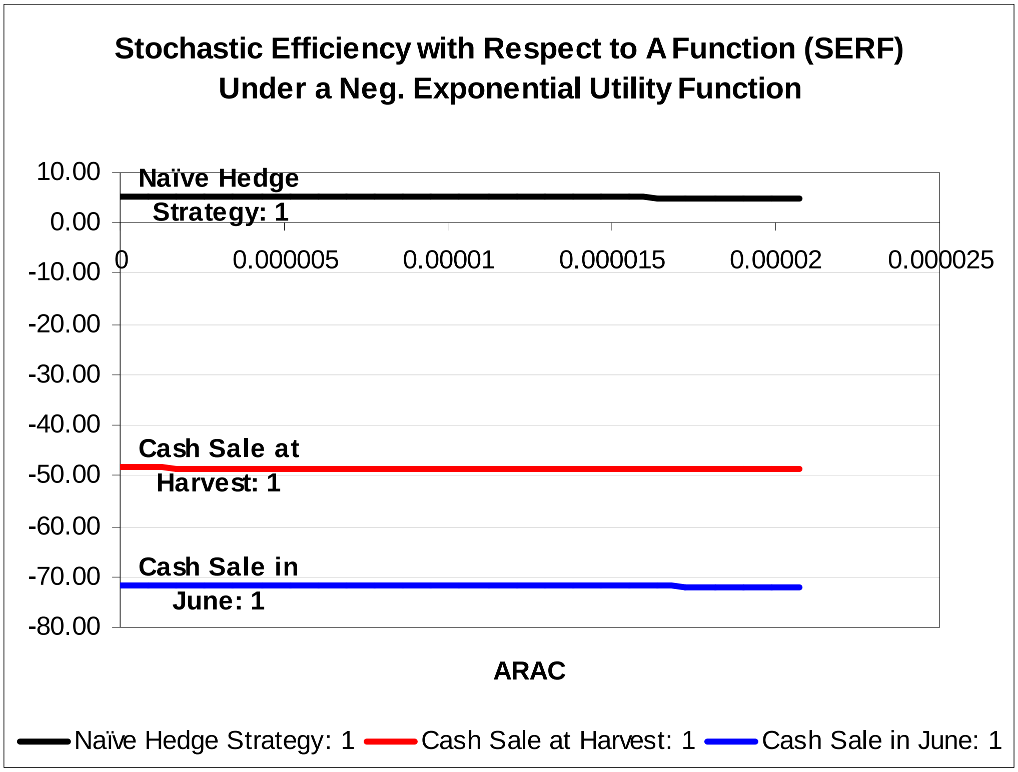

Figure 4: Irrigated Medium Yield Farm: SERF Analysis based on Certainty Equivalents

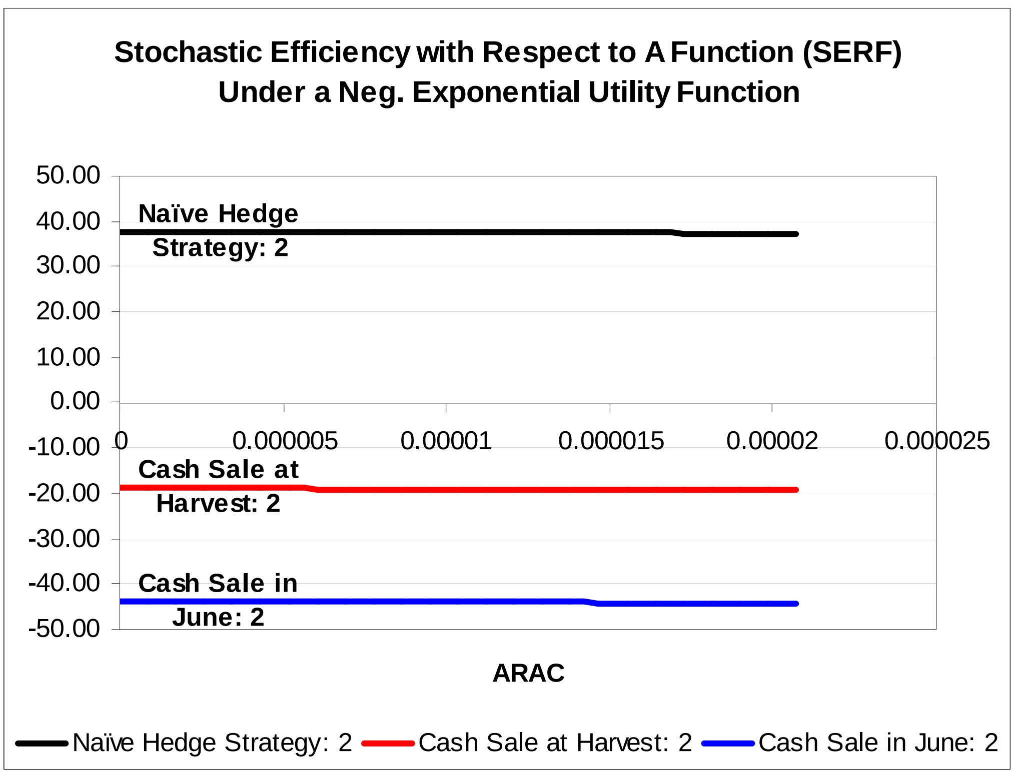

Figure 5: Irrigated High Yield Farm: SERF Analysis based on Certainty Equivalents

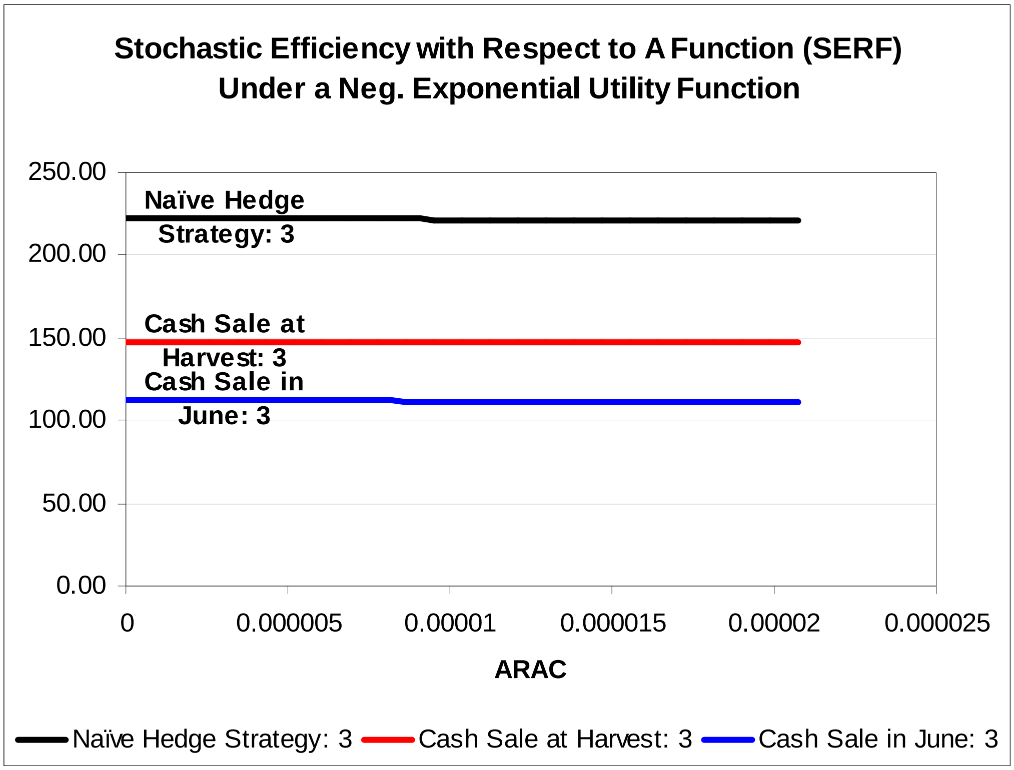

Figure 6: Dryland Low Yield Farm: SERF Analysis based on Certainty Equivalents

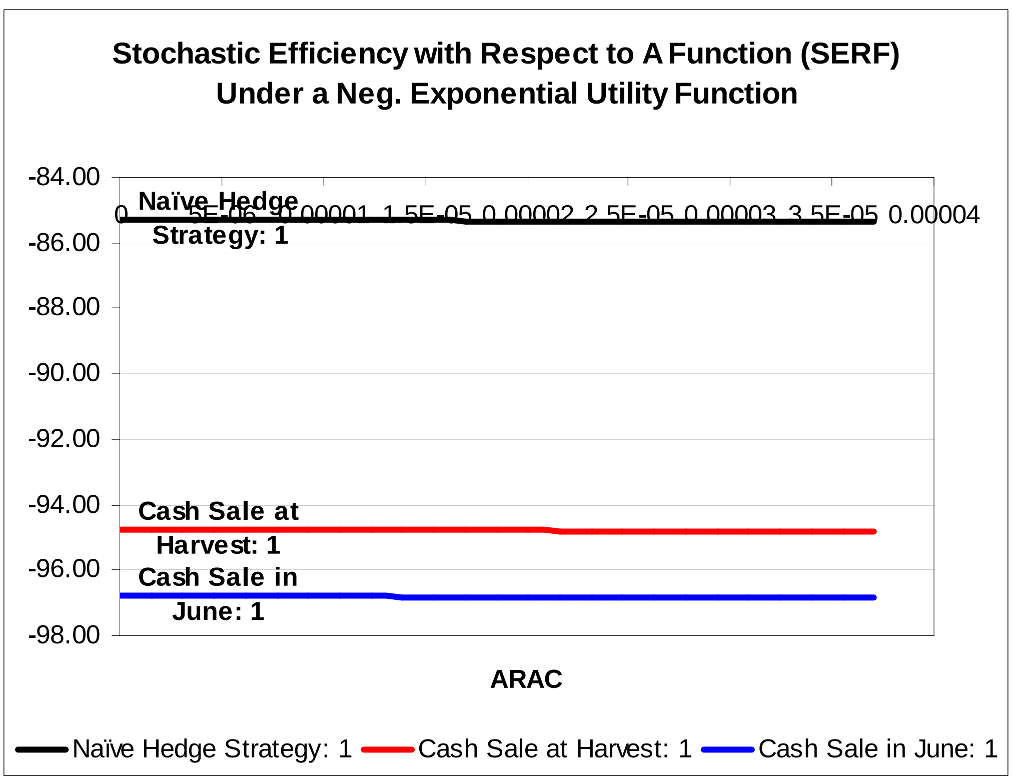

Figure 7: Dryland Medium Yield Farm: SERF Analysis based on Certainty Equivalents

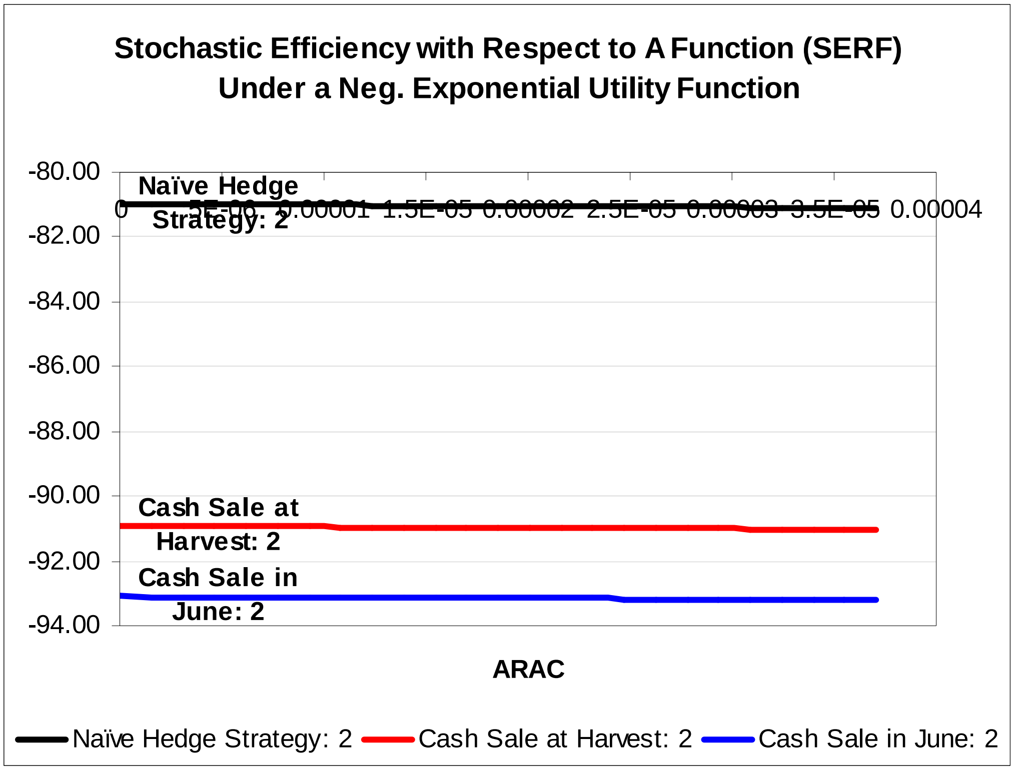

Figure 8: Dryland High Yield Farm: SERF Analysis based on Certainty Equivalents